



# **MARKSCHEME**

**May 2014**

**BIOLOGY**

**Standard Level**

**Paper 3**

13 pages

**Option A — Human nutrition and health**

1. (a) highest 34, lowest 17; **[1]**
- (b) BMI above 30 is obese;  
 more obesity/more values above 30 in 2003 than 1993;  
 maximum value of 40/higher maximum in 2003 compared to 34 in 1993;  
 greater range (of BMI values) / values above 30 in 2003;  
 mode/peak/most common BMI value has increased from 21 in 1993 to 22 in 2003;  
 mean BMI higher in 2003; **[3 max]**
- (c) change in eating habits/diet/junk food has led to more obesity;  
 reduced levels of physical activity may lead to more obesity;  
 population/migration/demographic changes (over 10 years);  
 more underweight individuals because of eating disorders/anorexia;  
 similar pattern in both sets of data so possibly no major changes in diet/lifestyle;  
 larger sample size in 2003 may account for greater range of BMI Values; **[3 max]**
2. (a) minerals are elements in ionic form/are ions/are inorganic while vitamins are organic compounds **[1]**  
*Do not accept vitamins are made in the body, minerals are not.*
- (b) fish / named fish / fish oil;  
 liver;  
 eggs/egg yolk;  
 dairy foods or example;  
 foods/cereals with added vitamin D; **[2 max]**  
*Do not accept action of sunlight.*
- (c) should take enough to meet individual's needs/RDA;  
 need sufficient to prevent scurvy/promote tissue regeneration;  
 higher intake (than minimum) may give protection against infections/boost immune system / *OWTTE*;  
 excess vitamin C is excreted in the urine/cannot be stored;  
 danger of rebound malnutrition / normal intake may not suffice after a period of excessive intake; **[3 max]**

3. (a) fibre cannot be digested;  
supports peristalsis in the intestine / adds bulk/prevents constipation;  
may reduce the risk of intestinal disorders/cancer;  
reduces blood cholesterol;  
bulk in stomach may help to prevent obesity (by the feeling of fullness);  
slows sugar absorption/helps prevent diabetes; *[2 max]*
- (b) food miles measure how far food has travelled from production to consumption;  
local food may cause less air pollution/greenhouse gas emissions/traffic  
congestion;  
supports local producers;  
encourages a more diverse local food economy;  
local food is fresher/tastier/more vitamins;  
transport of food allows increased choice/supports economies in developing  
countries;  
eating local seasonal food has a lower environmental impact; *[3 max]*

**Option B — Physiology of exercise**

4. (a) *men: 60–69 (years)*  
*women: 50–59 (years)*  
*Both needed for [1].* **[1]**
- (b) more women than men have (at least some) muscle mass loss in all age categories / fewer women have normal muscle mass in all age categories;  
onset of severe muscle mass loss earlier in men (18–29) than in women (30–39) / women lose muscle mass at an earlier age than men;  
muscle mass loss continues to increase with age in women but plateaus in men;  
muscle mass loss increases with age in both men and women; **[2 max]**
- (c) less exercise / injury / illness (preventing exercise);  
less protein in the diet / poverty / dementia (resulting in poor diet choices);  
normal result of aging / less regeneration;  
reduced hormone output; **[2 max]**
- (d) (exercise will) help to build up muscles/improve stamina;  
intense exercise will help to build up fast muscles/improve strength;  
level of exercise adjusted to suit age group;  
improve balance / avoid injuries due to falls; **[2 max]**
5. (a) volume of air taken in or out with each inhalation/exhalation / *OWTTE* **[1]**
- (b) more (cell) respiration / ATP production causes a greater demand for O<sub>2</sub>/production of CO<sub>2</sub>;  
increased tidal volume allows for increased supply of O<sub>2</sub>/removal of CO<sub>2</sub>;  
increase concentration gradients in lungs; **[2 max]**
- (c) blood flow to the brain is unchanged during exercise;  
blood flow to the heart muscle/skeletal muscles/skin is greater during exercise;  
blood flow to the kidneys/stomach/intestines/other abdominal organs is reduced during exercise; **[2 max]**

6. (a) (intense) exercise leads to anaerobic respiration/production of lactate;  
lactate turned into pyruvate (in the liver);  
pyruvate broken down/respired aerobically/requires additional oxygen;  
increased ventilation continues after exercise has stopped;  
replenish stored ATP / CP;  
reoxygenate myoglobin; *[3 max]*
- (b) (i) the physical condition of the body (that allows) for a particular  
exercise/activity *[1]*
- (ii) exercising at speed indicates effective anaerobic respiration;  
involves fast muscle activity;  
indicates fitness for (short bursts of) intense exercise / sprinting;  
not adequate (as a way of measuring fitness) for activities that require  
stamina / aerobic exercise / exercise involving slow muscle activity; *[2 max]*

**Option C — Cells and energy**

7. (a) clay-bound enzyme with copper chloride [1]  
*Both needed for [1].*
- (b) both reduce enzyme activity;  
 copper chloride causes a greater decrease;  
 accept a numerical comparison of the reduction in activity; [2 max]
- (c) reduces the activity of/inhibits both free and bound enzymes;  
 reduces the activity of/inhibits free enzyme more than the control;  
 greatest inhibition/reduction in activity of the clay-bound enzymes;  
 correct numerical comparison; [2 max]  
*Answers must be comparisons not just quoted numbers.*
- (d) copper binds to the enzyme away from the active site;  
 this changes the shape of the active site;  
 prevents substrate binding; [2 max]
8. (a) (i) X [1]  
 (ii) Z [1]  
 (iii) W [1]
- (b) C2 compound/acetyl (Co A) reacts with a C4 compound/oxaloacetate;  
 C6 compound/citrate formed;  
 two carbons are removed (in steps) / carbon dioxide/CO<sub>2</sub> is formed;  
 C4 compound / oxaloacetate is regenerated;  
 ATP is formed;  
 reduced NAD/NADH/FADH is formed; [3 max]  
*Accept suitably annotated diagram.*
9. (a) hydrogen ions released by photolysis of water (by photosystem II);  
 proton pumps use energy to move hydrogen ions to the thylakoid interior;  
 against concentration gradient;  
 small volume / narrow space inside thylakoid allows concentration to build up; [2 max]
- (b) concentration of H<sup>+</sup> ions / protons inside the thylakoid creates a (electrochemical) gradient;  
 the H<sup>+</sup> ions diffuse through the thylakoid membrane (into the stroma);  
 via ATP synthase;  
 process is called chemiosmosis;  
 ATP is formed from ADP and Pi; [3 max]

**Option D — Evolution**

10. (a) *length range*: accept answers in the range 270 to 350 (mm)  
*age range*: accept answers in the range 3.3 to 2.4 (millions of years) [1]  
*Both needed for [1].*
- (b) the ranges overlap/are similar;  
*H. erectus* has the shortest value / *H. neanderthalensis* has the longest value;  
 femur length of *H. erectus* changes over time, whereas *H. neanderthalensis* does not; [2 max]
- (c) overall trend of increasing femur length implies evolutionary advantage;  
 example given from the data;  
 species with shorter femurs died out;  
 may allow for more energy-efficient/faster movement/upright posture/gait;  
 taller to see predators;  
 overlap in ranges (for more recent specimens) suggests no strong selective advantage;  
 evidence not strong since few specimens exist; [2 max]
- (d) few older specimens / gaps in the fossil record;  
 fossil specimens may not be identified correctly;  
 age of specimens may not be accurate;  
 fossils may be incomplete / femur lengths of incomplete fossils are estimates; [2 max]
11. (a) internal chemical environment different from the surroundings [1]
- (b) some prokaryotes carried out photosynthesis;  
 oxygen is a waste product of photosynthesis; [1 max]
- (c) endosymbiotic theory;  
 endocytosis / engulfing of free-living organisms to form mitochondria/chloroplasts;  
 mitochondria/chloroplasts have (circular) DNA and (70S) ribosomes;  
 mitochondria/chloroplasts have similar size to prokaryotes;  
 double membrane suggests engulfing by endocytosis;  
 mitochondria/chloroplasts are capable of replicating independently;  
 it is a theory that cannot be repeated/ falsified; [3 max]

12. (a) (i) the time taken for radioactivity (of a radioisotope) to fall to half of its original level/for half of the atoms of the isotope to decay **[1]**
- (ii)  $^{40}\text{K}$  decays into  $^{40}\text{Ar}$ ;  
ratio/proportion of  $^{40}\text{K}$  to  $^{40}\text{Ar}$  indicates the age of the rock/fossil  
half-life of  $^{40}\text{K}$  is 1250 million years / 1.25 billion years;  
 $^{40}\text{K}$  can (only) be used to date very old samples / over 100 000 years; **[2 max]**  
*Do not accept if reference to age is less than 100 000 years.*
- (b) members of a species can (freely interbreed and) produce fertile offspring;  
species may be identified according to appearance / morphological features;  
some members of a species vary morphologically/are polymorphic;  
some morphologically similar organisms produce sterile offspring (so are not part of the same species);  
multiple/a combination of features/genetic/DNA may be used (to define a species);  
some species reproduce asexually;  
sometimes a species can only be identified by the genes / DNA; **[3 max]**



**Option E — Neurobiology and behaviour**

13. (a) before antler casting/January, February, March groups are 100 % male;  
 after antler casting percentage of males decreases;  
 reaches lowest value after velvet shedding/in September, October;  
 (from October to December) percentage of males increases to 100%; **[2 max]**
- (b) antler casting begins in March / begins at the same time each year;  
 antler casting ends earlier/occurs in a shorter time period in 1981 than in other years;  
 velvet shedding happens in July / at the same time each year;  
 velvet shedding lasts for (almost) the same length of time each year; **[2 max]**  
*For [2] both antler casting and velvet shedding must be mentioned.*
- (c) (percentage of males falls as) females join social groups for breeding;  
 group may be dominated by a single male who drives off other males;  
 after antler casting, males are more vulnerable to predators;  
 after breeding, females leave the groups (so percentage of males increases);  
 males form new social groups where dominance hierarchy is established; **[2 max]**
- (d) increasing day length/temperature may stimulate antler casting;  
 change in diet;  
 cues from the behavior of other animals;  
 may involve hormones released in response to external stimulus; **[1 max]**  
*Do not accept changes in the weather or global warming.*

14. (a) sound waves/vibrations in air cause ear drum/tympanic membrane to vibrate;  
 vibrations amplified by middle ear bones/ossicles/malleus, incus, stapes;  
 causes oval window/fluid in cochlea to vibrate;  
 stimulates mechanoreceptors/hair cells;  
 auditory nerve passes nerve impulse to brain; **[3 max]**

(b)

<b>Rods</b>	<b>Cones</b>
function well in dim light / more sensitive to low light	function well in bright light;
absorb all wavelengths of visible light / not responsible for colour vision	sensitive to red, green or blue wavelengths / responsible for colour vision;
poor visual acuity / impulses from several rods pass to a single neuron in the optic nerve	good visual acuity / impulses from a single cone pass to a single neuron in the optic nerve;

*Do not accept “rods detect black and white images”.*

**[2 max]**

15. (a) alcohol / benzodiazepines / tetrahydrocannabinol (THC) / marijuana / other valid example **[1]**  
*Do not accept brand names.*
- (b) psychoactive drugs may increase/decrease post synaptic transmission;  
can affect mood/behaviour;  
increase / decrease the release of neurotransmitters;  
delay the breakdown of neurotransmitters;  
interfere with storage/re-uptake;  
mimic the action of neurotransmitters / block receptors;  
reduce the effect of excitatory neurotransmitters / increase the effect/release of inhibitory neurotransmitters; **[3 max]**
- (c) some individuals are genetically predisposed (whilst others are not);  
some individuals are affected by peer pressure / cultural traditions;  
some individuals suffer (named) social problems / trauma;  
the pleasurable effects of dopamine may lead to addiction; **[2 max]**

**Option F — Microbes and biotechnology**

16. (a) bacteria killed at low pH/below 4.4–4.7;  
 growth inhibited at higher pH/between 4.4 and 6.5;  
 bacteria grow at higher pH/above 6.3–6.5; [2 max]
- (b) growth decreases as nisin concentration increases;  
 even at high nisin concentrations some bacteria survive;  
 bacteria are killed at all pH values with high nisin;  
 growth only occurs at very low NaCl concentrations;  
 growth only occurs at lower NaCl or higher pH;  
 numerical response in place of the above; [3 max]
- (c) pH 6.5–6.8 or 8.5 (*the question does not state which concentrations of NaCl*) [1]
- (d) less salt is used;  
 food can be preserved at higher pH;  
 prevents disease/food poisoning caused by (pathogenic) bacteria; [1 max]
17. (a) may have naked or enveloped capsid;  
 shape of the capsid/virus can vary;  
 DNA or RNA (but not both);  
 DNA/RNA may be single stranded or double stranded; [2 max]
- (b) (i) gene therapy / description of the process [1]
- (ii) SCID/other valid example [1]
- (c) reverse transcriptase (enzyme);  
 obtained from retroviruses (such as HIV);  
 used to make DNA/cDNA from (mature) mRNA;  
 without introns;  
 double strand completed by DNA polymerase;  
 double stranded DNA spliced into host DNA; [3 max]
18. (a) (i) arrow from atmospheric nitrogen to ammonia marked X [1]
- (ii) *Nitrosomonas* [1]
- (b) raw sewage contains pathogens/toxins which enter the water;  
 (organic content/live microorganisms) cause eutrophication;  
 (eutrophication) causes algal blooms;  
 deoxygenation/high BOD;  
 causes death of aquatic organisms; [2 max]

**Option G — Ecology and conservation**

19. (a) 2006 **[1]**
- (b) increases steadily from 1998 to 2002 and plateaus between 2002 and 2006;  
overall increasing trend / lowest percentage in 1998 and highest in 2006; **[1 max]**
- (c) fledging success is always greater than breeding success;  
show opposite trends before 2002 (*accept a description*);  
follow (closely) similar trends after 2002; (*accept a description*);  
maximum difference (in percentage) in 1998;  
difference remains smallest between 2002 and 2006; **[2 max]**
- (d) many of the eggs laid do not hatch but those that do hatch fledge successfully **[1]**
- (e) eggs may have been laid late in the breeding season so warmer temperatures /  
shorter time for parental care (leading to low fledging success);  
predation/disease of parents/chicks;  
weather conditions at time of fledging may have been unusually harsh;  
named resource / food may have been reduced; **[2 max]**
20. (a) organisms are counted/estimated/identified;  
along a line/string/set of markers;  
abiotic factors can be measured;  
results are used to correlate distribution with an abiotic variable; **[2max]**
- (b) measure the area where the population lives;  
count individuals inside a quadrat;  
use random sampling;  
sample a representative area / place sufficient quadrats;  
calculation: mean number per quadrat x total area / area of the quadrat;  
*Do not accept quadrant.* **[2 max]**

21. (a) (i) temperature;  
water;  
light;  
soil pH;  
salinity;  
mineral nutrients;  
presence of pollinators/dispersal vectors;  
herbivores;  
interspecific competition; *[2 max]*
- (ii) only one species can occupy a niche indefinitely;  
more than one species results in competition for breeding sites/food/other  
named resource;  
one species will disappear from the ecosystem/be excluded; *[2 max]*
- (b) lichens/mosses colonise the area;  
lichens (release acids which) break up rocks;  
decomposed plants/mosses/lichens contribute to soil development/increase  
organic matter;  
minerals are extracted (by microorganisms) from underlying rocks and  
accumulate in soil;  
root network and surface covering of plants help reduce erosion so soil can  
accumulate;  
water retention increases; *[3 max]*
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